DETERMINATION OF THE EFFECT OF HEATING THE INTERNAL SURFACES OF THE WORKING CHAMBER OF A COTTON GIN MACHINE ON PRODUCTIVITY AND ITS OPTIMAL PARAMETERS

https://doi.org/10.5281/zenodo.18543718

Sharipov Jahongir Kahramon oglu
Doctoral student
Namangan Institute of Engineering and Technology, Uzbekistan.
E-mail: sharipovjahongir1997@gmail.com
Mirzaumidov Asilbek Shuhratjonovich
Doctor of Technical Sciences, Professor
Namangan Institute of Engineering and Technology,Uzbekistan.
E-mail: bek_mirzaumidov@mail.ru
Yunusov Salohiddin Zununovich
Doctor of Technical Sciences, Professor
Tashkent State Transport University, Uzbkeistan.

Abstract

This paper investigates the effect of heating the internal surfaces of the working chamber of a cotton gin machine on its productivity based on experimental research. During the study, the front apron and lintel beam surfaces of the working chamber were heated at specified temperature levels, and the productivity of the gin machine was determined under different cotton moisture conditions. Based on the experimental data obtained, mathematical regression equations describing the productivity of the machine were developed, and their adequacy was evaluated. Using the regression models, the heating process of the internal surfaces of the working chamber was optimized, and the optimal temperature values providing maximum productivity were determined. The results show that heating the internal surfaces of the working chamber is an effective technological solution for increasing the productivity of cotton gin machines.

Keywords

cotton gin machine, working chamber, internal surface heating, productivity, regression equation, optimization.

Introduction. Increasing the productivity of cotton gin machines is one of the key factors in improving efficiency in the cotton ginning industry. Insufficient productivity leads to a slowdown of technological processes, underutilization of production capacity, and increased consumption of resources. Therefore, research

AMERICAN JOURNAL OF MULTIDISCIPLINARY BULLETIN
ISSN: 2996-511X (online) | ResearchBib (IF) = 9.512 IMPACT FACTOR
Volume-4| Issue-2| 2026 Published: |28-02-2026|

aimed at improving the operating process of cotton gin machines remains highly relevant.The productivity of a cotton gin machine depends on several factors, among which the movement conditions of raw cotton inside the working chamber play a significant role. Practical experience shows that heating the internal surfaces of the working chamber affects the physical condition of raw cotton and contributes to stabilizing the ginning process. However, the influence of this method on machine productivity and the determination of optimal heating temperature values have not been sufficiently substantiated in previous studies.

Literature Review. The research results of S. Z. Yunusov show that the energy efficiency of a saw gin machine can be improved by applying heat to the front apron section of the working chamber. In studies conducted by S. Z. Yunusov, experimental analyses were carried out on a 30-saw laboratory gin machine corresponding to the geometric dimensions of the widely used 5DP-130 and 4DP-130 gin machines in Uzbekistan. The results confirmed that supplying heat to the front apron significantly reduced friction forces between the raw material roll and the internal surface of the front apron. Consequently, this led to a reduction in the overall energy consumption of the gin machine [1].

A. Sarimsaqov proposed the installation of accelerators on the side walls of the working chamber in order to increase the rotation of the raw material roll, which made it possible to increase the machine productivity and reduce the mass fraction of fiber defects and impurities by 0.5%, the damage to seeds after ginning by 0.5%, and the seed fuzziness by 0.7% [2].

N. M. Safarov investigated the total energy consumption of raw cotton at different densities and determined that approximately 16 kW of energy is consumed to overcome the friction forces between the internal chamber of a saw gin machine and the raw material roll [3].

In the studies conducted by S. Isroilov, in order to reduce the friction forces between the front apron of the working chamber and the raw material roll, additional rotating rollers were installed on the internal surface of the front apron when the density of the raw material roll increased, which made it possible to save up to 4 kW of electrical energy consumed by the electric motor [4]. The reduction of friction forces on the wall led to a decrease in saw vibrations, which had a significant effect on improving fiber quality indicators [5]. In addition, due to the reduction of friction forces between the raw material roll and the wall, the rotation speed increased, which was also proven to lead to an increase in the productivity of the gin machine [6, 7].

Materials and methods. The research was conducted using a 30-saw cotton ginning machine. During the experiments, heat was supplied to the internal surfaces of the working chamber of the gin machine, namely the front apron and back apron sections, at different temperature levels, and the effect of this treatment on the machine productivity was investigated under experimental conditions (Figure 1). The temperatures of the internal surfaces of the working chamber were set at 60°C, 70°C, and 80°C. The experiments were carried out using Andijan -35 raw cotton of industrial grade III, class 2, with relative moisture contents of 9%, 12%, and 15%. The tests were performed under various combinations of temperature and moisture, and in each case the productivity of the gin machine was determined and recorded. The conducted experiments made it possible to evaluate the effect of heating the internal surfaces of the working chamber on the productivity of the gin machine and to determine the optimal temperature values.

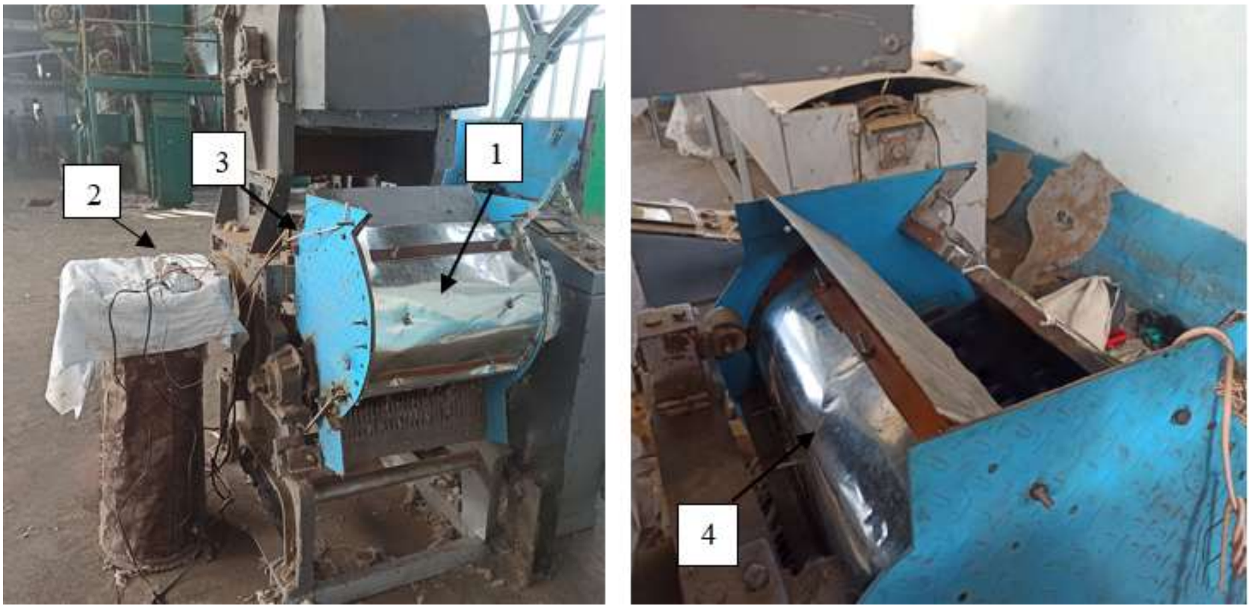


Figure 1. Installation of heating elements on the internal surfaces of the front apron and front bar.

1 – front apron with heating system; 2 – temperature controllers; 3 – heating cable; 4 – front bar with heating system

It is well known that the productivity of a saw gin machine depends on the rotational speed of the raw material roll in the working chamber, the number of saws, and several other factors. The productivity of the working chamber of a saw gin machine can be theoretically determined using the following equation:

$$\Pi = \frac{Q}{\tau_{o'r}} \cdot A, \qquad (1)$$

Where:

Π is the productivity of the working chamber in terms of fiber output; Q is the mass of the raw material roll; $\tau_{o'r}$ is the average residence time of fiber and seeds in the working chamber; A is a constant characteristic of the ginning process.

Equation (1) indicates that the productivity of a gin machine is directly proportional to the mass of raw cotton present in the working chamber and inversely proportional to the residence time of the raw cotton within the chamber. Consequently, an increase in machine productivity can be achieved either by increasing the amount of raw cotton inside the working chamber or by reducing the residence time of the raw cotton within the chamber.

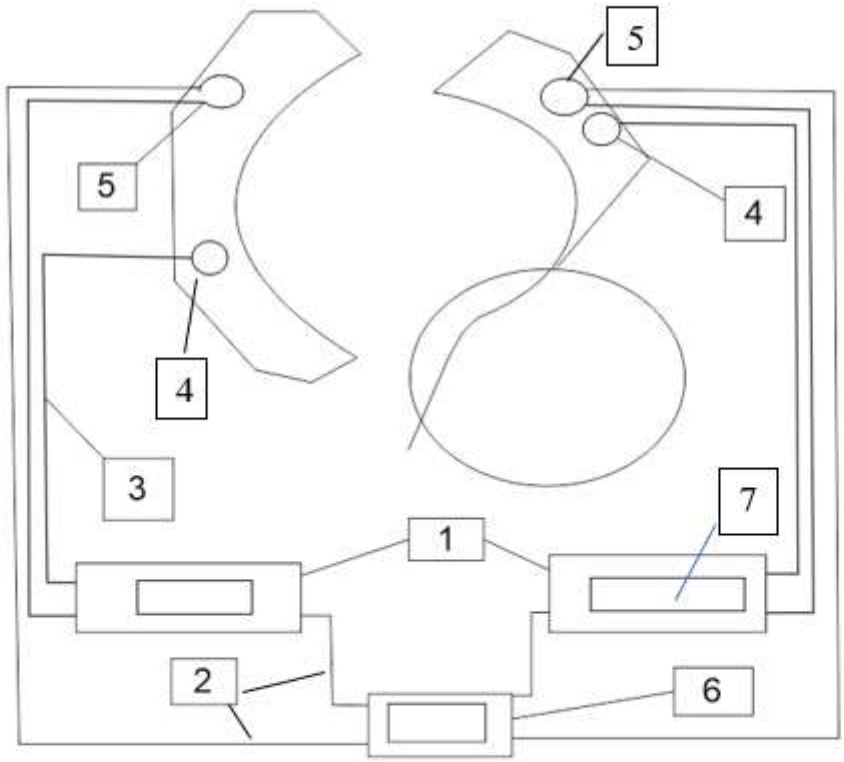


Figure 2. Kinematic diagram of the heating system:

1 – temperature controllers; 2 – electrical conductors; 3 – thermosignal transmitter; 4 – temperature sensor; 5 – electric heating element; 6 – electric power supply (220 V); 7 – control panel.

Figure 2 illustrates the heating system applied to the internal surfaces of the experimental gin machine. Electrical power (6) is supplied to the temperature controllers (1) through the electrical conductors (2). Using the control panel (7), the required temperature for heating the internal surfaces of the working chamber is set. The internal surfaces of the working chamber are heated by means of electric heating elements (5), which receive power through electrical conductors (2) connected to the temperature controllers. The temperature of the internal surfaces of the working chamber is measured by a special sensor (4) connected to the temperature controller (1) via a thermosignal transmitter (3).

Supplying heat to the internal walls of a saw gin machine leads to a reduction in the friction forces between the raw material roll and the internal surfaces. This, in turn, results in an increase in the rotational speed of the raw material roll, accelerates the discharge of seeds from the working chamber, and ultimately contributes to an increase in machine productivity.

Results. The experimental tests of the new design of the working chamber of the saw gin machine, incorporating a system for heating the internal surfaces, yielded positive results (Table 1).

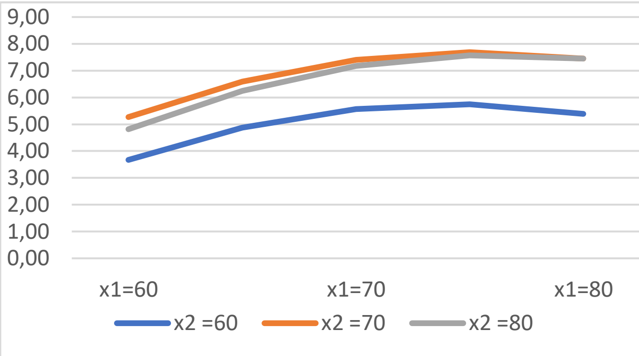
Table 1

Test mode	Cotton variety and grade	Front apron ... rature	Front bar inner- ... e	Cotton moisture	Ginning ... ctivity	
		^0C	^0C	%	Kg/h	Kg/h
	Andijon 35	-	-	9	10,34	310,2
	-//-	-	-	12	7,82	234,6
	-//-	-	-	15	7,24	217,2
1	-//-	80	80	12	8,40	252,0
2	-//-	80	60	12	8,27	248,2
3	-//-	60	80	12	8,16	244,9
4	-//-	60	60	12	8,11	243,3
5	-//-	80	70	15	7,72	231,8
6	-//-	80	70	9	10,86	326,0
7	-//-	60	70	15	7,56	227,0
8	-//-	60	70	9	10,72	321,7
9	-//-	70	80	15	7,71	231,3
10	-//-	70	80	9	10,92	327,6
11	-//-	70	60	15	7,56	227,0
12	-//-	70	60	9	10,70	321,1
13	-//-	70	70	12	8,39	252,0
14	-//-	70	70	12	8,39	251,7
15	-//-	70	70	12	8,40	252,2

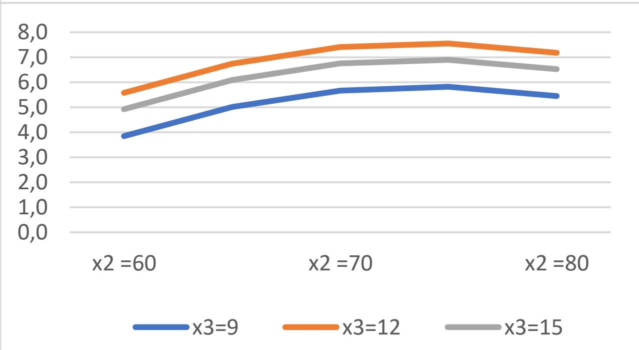
For the purpose of result optimization, the Central Composite Design (CCD) method was applied. CCD is a non-compositional experimental design method used to determine optimal values in multifactor experimental studies. According to this method, three experimental trials were conducted for each parameter combination, as presented in the table above. Based on the obtained results, a mathematical regression equation describing the productivity of the saw gin machine was derived. The adequacy of the regression model was verified using the Fisher and Student criteria.

$$Y = 7{,}4 + 1{,}09x_1 + 0{,}8x_2 + 0{,}54x_3 + 0{,}23x_1x_2 + 0{,}2x_1x_3 - 1{,}04x_1^2 - 1{,}03x_2^2 - 1{,}19x_3^2$$

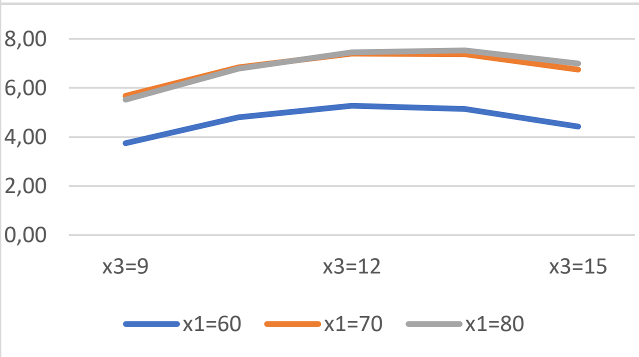
The calculated mathematical regression model makes it possible to describe the behavior of the investigated process with sufficient accuracy. The interaction graphs are presented as follows:



(Y) Dependence of the increase in machine productivity (%) on the heating temperature of the internal surface of the front apron (X_1) and the heating temperature of the internal surface of the front bar (X_2).



(Y) Dependence of the increase in machine productivity (%) on the heating temperature of the internal rear wall (X_2) and the relative moisture content of the cotton supplied to the working chamber (X_3).



(Y) Dependence of the increase in machine productivity (%) on the relative moisture content of the cotton supplied to the working chamber (X_3) and the heating temperature of the internal surface of the front apron (X_1).

Analysis. The results indicate that, during the heating process, machine productivity increases to a certain extent as a result of supplying heat to the internal surfaces. The interaction graphs of factors X_1, X_2, and X_3 show that an increase in the temperature of both internal walls of the working chamber leads to a corresponding increase in productivity. Under maximum conditions, when the temperature of the internal front wall is 80°C and the temperature of the front bar is 70°C, the productivity reaches its highest value; however, when the cotton moisture content exceeds 12%, a gradual decrease in productivity is observed. It was determined that under optimal parameters—80°C for the internal front wall and 70°C for the internal rear wall—the machine productivity increases by up to 7.4%.

Conclusion. In this study, the effect of heat application on productivity during the cotton ginning process was investigated. The results demonstrate that the combined influence of heating temperature and cotton moisture content significantly affects process efficiency. Furthermore, it was established that optimization of the heating system parameters leads to an increase in the productivity of the gin machine.

FOYDALANILGAN ADABIYOTLAR:

1. Юнусов С.З. Разработка эффективных конструкций и совершенствование научных основ расчёта параметров рабочих органов и механизмов пильных джинов. Диссертация на соискание учёной степени доктора технических наук Tashkent. – 2017 g.
2. Sarimsaqov A.U., Karimov A.I., Muradov R.M. Arrali jin ishchi kamerasidagi jarayonlarni amaliy va nazariy statik hisobi // Mexanika muammolari. – Toshkent, 2012. – № 2. B. 60-63.
3. Сафаров Н.М. Разработка методики определения динамических и технологических показателей пильного джинирования при различных плотностях хлопка-сырца. Диссертация на соискание учёной степени кандидата технических наук. Ташкент, 1997.
4. Isroilov, S., & Makhkamov, A. (2022, January). Improving Working Efficiency of Gin Saw by Learning Its Tribology. In Multidiscipline Proceedings of Digital Fashion Conference, Seoul, South Korea.
5. Akramjon, S., Sardorbek, I., & Shukhratjon, K. (2023). Improving Fiber Quality Output by Improving the Roll Box of the Gin Saw. Engineering, 15(4), 261-268.
6. Sarimsakov, A., Isroilov, S., & Kenjaeva, M. Methods to increase the efficiency of saw gin machine.(2022). Web of Scientist: International Scientific Research Journal, 3 (2), 654-659.
7. Mamatovich, A. S., Isroilov, S., Abdurakhimov, J., & Turgunov, S. The Definition Technological Parametres of One Chamber Two Saw Cylinders Gin. Latest Trends in Textile and Fashion Designing, 1, 17.